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NAVAL PHOTOGRAPHIC INTERPRETATION*

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All of us here assembled have probably heard the famous Chinese proverb, "A picture is worth 10,000 words." Some of us have even read the quotation from former Chief of the German General Staff, Werner von Fritsch, who, in 1939, said, "The Nation with the best photographic reconnaissance will win the next war." How many of us here really believe these statements, generally feel that the impact of photography on modern warfare is more significant than the impact of gunpowder on the warfare of its time? Yes, without a doubt, in the last 35 years photography has become the most widely used weapon of military conflict.

In the next twenty minutes I would like to tell you something about military photographic interpretation and, in particular, something about naval photographic interpretation. Further, I plan to describe in some detail one of the most important recent Navy developments to be used for photographic interpretation purposes.

In a general sense, anybody who looks at photographs and obtains information from them--whether ~~this~~ these data be military, civil, scientific, or spiritual--is a photo-interpreter. It seems unquestionable, then, that we are all photo-interpreters of a sort. The particular kind of photo-interpretation with which this paper is

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concerned is military photo-interpretation. The military or naval photo-interpreter deals largely, but not entirely, with aerial photographs. These photos may be positives or negatives, paper prints or transparencies, color, black and white, or ozalid; they may have been taken at any time, day or night, and may vary in frame size from 16 mm. to 9 by 18 inches or larger; the focal lengths of taking cameras may vary from 1 inch to 240 inches, and the photos may be taken from altitudes ranging from less than 100 feet to more than 50,000 feet. Usually the only standard conditions are:

1. The photo will nearly always cover a situation or locality not immediately accessible for direct observation from the ground.

2. The photo-interpreter must analyze the photographs and clearly report his findings as rapidly as possible.

The ultimate objective of all this effort is up-to-the-minute military intelligence--the collection, evaluation, and dissemination of military information upon which to base firm and proper decisions for tactical and strategic operations. Aerial reconnaissance is the most important activity for securing general military information and other essential data. These data are essentially photographic or photo supplements and include information about the enemy's holdings, terrain, or meteorological conditions as derived through visual, infra-red, radar, magnetometer, radiological, or other electromagnetic means. The aerial reconnaissance photography and supplementary data are used to produce intelligence, whether in the form of maps and charts or as detailed information about enemy installations or activities. In most rapidly developing tactical situations the

information extracted by the photo-interpreter is used directly as intelligence. However, under more general conditions photo-interpretation information or data do not become intelligence until another staff division (often including photo-interpreters making independent interpretations) evaluates the data, correlates them it with other information, rejects certain contradictions, and generally synthesizes a final end-product which is bona fide intelligence. In all cases, considerable care must be taken in evaluating the enemy's use of camouflage, dummies, and decoys designed to lure us into a false estimate of the situation.

Disastrous, indeed, is a lack of photo-reconnaissance over wide areas behind the enemy lines. Here we might recall the fate of the German armies fighting the Russians blindly, without adequate photo reconnaissance, on the Eastern Front in 1944-45; or the initial success of the German armies during the Battle of the Bulge when bad weather foiled our reconnaissance effort. More recently this truth was brough home in Korea where our aircraft were not permitted to fly north of the Yalu River. Such missions might have returned with photographic records revealing the state of build-up and full scope of Communist intent which explosively shattered the "home by Christmas" talk for our troops in 1950.

Such is an abbreviated background to military photo-interpretation and some of the consequences of its absence or failure. Let us now examine some naval photo-interpretation concepts and general photo-interpretation functions or requirements.

The U. S. Naval Photographic Interpretation Center, located at the Naval Receiving Station, Washington, D. C., functions under the over-all control of the Chief of Naval Operations and under the specific direction of the Photographic Division of the Bureau of Aeronautics. The Bureau of Aeronautics is responsible within the National Military Establishment for implementing the photographic requirements of the Navy, including the Marine Corps. This responsibility includes research, design, development, and testing of photographic equipment or systems peculiar to Navy requirements. The Joint Chiefs of Staff have assigned certain aspects of military photographic reconnaissance to the Department of the Navy.

In order for the Navy to fulfill its responsibility on our military team the specialized equipment developed must be capable of functioning from typical Navy photographic platforms. These platforms are usually very unstable and may be the hands of an underwater demolition team "frogman," a submarine, a surface man-of-war, a carrier-borne aircraft, a guided missile, or a combat marine under fire in the humid tropics or frigid arctic. The Navy must take and analyze photographs in support of amphibious operations. Beach gradients must be determined and Marine combat landing requirements must be met. Underwater photo-reconnaissance is required to chart obstructions and submarine-periscope photos are interpreted for identification of ship and costal targets. Aerial photographs must be interpreted or photogrammetrically analyzed for preparation of accurate maps and mosaics, port and shipping studies, urban and industrial analyses, airfield and aircraft studies, target folders,

coast and mining studies, missile orientation determinations, anti-submarine warfare evaluations, and the widest range of naval intelligence reports or estimates. Thus, the scope of Naval photographic interpretation requirements is extremely broad, and usually greater than that of the other services in that it embraces ground, air, surface, and underwater photography. New developments in naval photography to obtain the required coverage within and between the separate media listed were presented before last year's PSA Meeting by Captain J. H. McElroy, USN.

Most of the Navy's photo-interpretation is presently done at the Photographic Interpretation Center, generally referred to as PIC. PIC is repeatedly called upon to make detailed reports on all kinds of photographs. These reports vary in content and complexity from simple identifications or evaluations from subsurface periscope photography to complete beach intelligence studies for an amphibious operation which may be staged next week, a year from now, or never. PIC is also called upon to interpret photographs of coastal zones for studies of harbors, shipping, ports, air defenses, urban and industrial targets, etc. For example, an industrial study should indicate the work carried out, the processes accomplished in each building, the flow of operations from entrance of raw material to exit of finished product, and relative priority of separate targets or components thereof. In order to give accurate interpretations, Naval photo-interpreters are obliged to keep abreast of developments in their specific fields. An aircraft and airfield specialist must be familiar with latest developments in aeronautics. Similarly, the

industrial photo-interpreter must be cognisant of new processes in old industries as well as of significant progress in newly developed industrial lines. This necessity results from the fact that all interpretation is essentially a process of comparison based on the mechanics of recognition of an outline. As Katz (1) puts the problem, "What makes a photo-interpreter think that a little gray blob on a piece of flat paper is the image of a medium tank?" The U. S. Air Force is currently sponsoring important research in the field of psychological selection, testing, and subsequent training of photo-interpreters. The Navy PIC is endeavoring to establish some pattern of correlation between a man's score on the General Service Classification Test and his potential capabilities as a photo-interpreter.

Since photo-interpretation is basically a process of comparison, any interpretation not based on a previous review of a similar installation or proper photo thereof would be merely a guess, and guessing is a forbidden practice in photo-interpretation reporting. It is therefore necessary that the Navy PIC maintain a fairly complete file of textual and graphic information on fields related to photo-interpretation and photogrammetry work. These fields include Aircraft, Airfields, Amphibious Intelligence, Electronics, Geography, Industry, Ordnance, Urban Areas, Physical Vulnerability, Ships and Harbors, Terrain and Terrain Model Making, Transportation, Vehicles, Defenses, Communications, etc. In each field the photo-interpreter is generally concerned with photos or drawings, exterior dimensions, design or form characteristics, operating characteristics, locations, orientations,

physical characteristics, and scores of other details--any one or combination of which may be all that is required to make a substantially complete, timely photo-interpretation analysis of a scene or situation in the past, present, or future. Because photo-interpretation is basically a process of comparison, one of the most important tools in the hands of the photo-interpreter is repeated or comparative photo coverage of an enemy-held area. The full scope of the enemy's intention or evaluation of the area's importance is made manifest by the type and rate of growth of new construction, defenses, communications, camouflage, etc. Contrariwise, lack of new construction, bomb damage repair, shipping, aircraft, or defensive activity in general may mean relative abandonment of the site or its relegation to a secondary role in the national effort.

These basic concepts and many others are well known to most photo-interpreters who ask for little and often produce much from the photographs supplied them. Generally the photo-interpreter is most happy to work with vertical aerial photos at scales around 1:10,000, with adequate stereo overlap and resolution of 10-15 lines per millimeter. However, each aspect of photo-interpretation has its own photo requirements (2,3), some of which are more and others less exacting. Photo-interpreters are also becoming more skilled in the handling of oblique aerial photos. Here, much pioneering work has been done by Navy photogrammetrists in the creation of procedures and devices for rapidly translating the perspective impressions of ground objects imaged in oblique photos to the more significant plan and height dimensions. Despite the low quality photographs and lower

quality analytical equipment used in World War II, photo-interpreters did a remarkably accurate job as verified by postwar studies of the U. S. Strategic Bombing Survey. More recently, it has been questioned whether photoreconnaissance aircraft might be expected to fly conventional missions over well-defined target and return, and, if so, whether photographs made at near-sonic speeds would be of any value. Conditioned by such thoughts as these and the natural space limitation of carrier-borne aircraft, the Navy has sponsored the development of the Fairchild XCA-12 70 mm., single-frame, image-motion compensation camera, the prototype of which has already completed its initial tests successfully. The XCA-12 shown in fig. 1 is designed for photography at speeds up to 660 knots or more and altitudes ranging from 250 to more than 50,000 feet, if necessary. It is generally agreed that "on-the-deck" flying is the best flying altitude to avoid radar detection and AA fire. The camera has 1/2-, 3-, 6-, and 12-inch lens cones and operates at speeds up to 10 exposures per second, the film moving at a maximum velocity of 9 inches per second.

Fig. 2 presents the results of a study on image-motion compensation by Mr. G. T. McNeil of PIC, who has pioneered Navy theoretical photogrammetric work on image-motion compensation. Two important results of the study are: (1) as shown in fig. 2, considerable variation from the correct film velocity is permissible without appreciable loss of the advantage of image-motion compensation; and (2) in the case of the XCA-12 camera with a recycling time of 1/10 second there is no practical advantage in film velocities

over 9 inches per second. It is well known that the enormous fuel requirement of jet fighters leaves little room for cameras. The single XCA-12 with control boxes, relays, etc., weighs approximately 125 pounds. The small size of the camera makes multiple installations possible, thus permitting several types of photography to be obtained on a single mission. The Navy is not proposing the XCA-12 as a cure-all for all our reconnaissance requirements. It is being suggested as an answer to our low-altitude, high-speed photo-interpretation and photo-mapping requirements.

Problems of image resolution have also been considered. The special 1 1/2-inch Cartogon lens developed by Bausch and Lomb for the XCA-12 has been bench-tested by the Bureau of Standards and found to resolve more than 60 lines per millimeter. Although development of associated photo-processing and enlarging equipment has been required for the XCA-12, initial photographic interpretation may be carried out on a strip contact print from the roll of 70-mm. negatives, individual frames of which are separated just enough for normal viewing through the Abrams- or Fairchild-type pocket stereoscope. Thus a single roll of up to 400 exposures may be relatively quickly scanned, and only the more important frames tabbed for enlargement, diapositives, or other special handling.

To handle the Navy's high-speed, low-altitude mapping problems over beaches, coastal areas, or other significant enemy holdings, the XCA-12 70-mm. negatives may be subjected to a 0.74 reduction in a special Reduction Printer being developed by Bausch and Lomb on Navy contract. These diapositives made from 1 1/2-inch focal length

photography have the same wide-angle cover advantages as the conventional K-17 or CA-8 6-inch focal length, 9- by 9-inch photography. Further, the Navy may use its own wide-angle Bausch and Lomb Multiplex Projectors for making maps from the XCA-12 photography, or it may enlist the help of a score or more other government, military, or civilian agencies in the United States which have Bausch and Lomb Multiplex Projectors. Thus, the Navy's mapping capabilities with XCA-12 photography have great potential flexibility.

It appears that the XCA-12 camera holds many possibilities of meeting photo-interpretation requirements in an age of high-speed jet aircraft. Despite the fine use made by the Navy of continuous strip photography at Okinawa and elsewhere in the Pacific, largely for underwater depth determinations, the continuous strip camera appears to be at a disadvantage when compared with the XCA-12. The single-frame image-motion compensation camera (IMC) clearly outperforms the continuous strip (CS) camera in a metrical sense. This is largely due to the fact that the IMC camera contains a shutter, while the CS camera is shutterless. Any error in film velocity, owing to lack of synchronization, is reduced 500 times (1/500 second shutter) by the IMC camera, while the full proportionate error of the film velocity is reflected in measurements along the line of flight of the CS camera. The IMC camera "freezes" the perspective for an interval of 1/500 second, enabling the photogrammetrist to establish a definite film plane for subsequent metrics. The CS camera, on the other hand, continuously records the lines of random orientation, defying establishment of a film plane for a comprehensive metrical analysis. It is apparent how critical the requirement becomes for absolute synchronization of film velocity

and ground speed in the CS camera. On the other hand, the IMC camera generally permits the pilot ample flight tolerances. As may be noted from the chart in fig. 2, where maximum image movement is held at ± 0.002 inches when the film velocity is maintained at 2 inches per second and the altitude at 500 feet, the ground velocity of the plane can vary from 200 to 600 knots. Under the same limitation of film velocity of 2 inches per second, with a ground velocity of 395 knots, the altitude can vary from 340 to 1,000 feet with a maximum image movement of ± 0.002 inch. In general, it appears that the CS camera has certain specific, limited uses not discussed here (5), but lacks the wide, general capabilities of the IMC camera which adopts the moving film principle without completely sacrificing the single-point perspective so important to photogrammetric analysis, and is relatively free from failures of film-speed synchronization and aircraft orientation.

Many other developments are being sponsored by the Navy for photo-interpretation purposes but they must wait to be described at some later meeting. I have chosen to describe the XCA-12 in detail because it is one of the most important recent Navy-sponsored developments for photo-interpretation purposes. Much more will be heard of this development. However, despite our collective efforts, much remains to be done and there is no time to waste. The manufacturers mentioned in this paper are only a few of many who are helping the Navy effort in photography and photographic interpretation. The continued development of better equipment and materiel by American industry, the sustained cooperation within our military services,

and the steady contribution of ideas and inspiration by military and civilian personnel, particularly those working in technical groups such as the Photographic Society of America, have done much toward making photography the most widely used weapon of military endeavor. Naval photography depends directly or indirectly upon all of us in order to make continued progress and advancement for the general benefit and defense of our country. We are strong, but not strong enough to relax our efforts even temporarily. Our enemies also work hard, watch us intently, and plan minutely. Let us meet them where necessary in combat with the fullest application of our collective civil and military strength at those points indicated by our best military photographic intelligence effort. Finally, let us each day apply our photographic talents unselfishly and work diligently with another ancient Chinese proverb clearly in mind -"The More We Sweat in Peace, The Less We Bleed in War."

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